Physiological Characterization of Cut-to-Cut Yield Variations of Alfalfa Genotypes under Controlled Greenhouse Conditions

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The 22nd International Grassland Congress (Revitalising Grasslands to Sustain Our Communities) took place in Sydney, Australia from September 15 through September 19, 2013.

Proceedings Editors: David L. Michalk, Geoffrey D. Millar, Warwick B. Badgery, and Kim M. Broadfoot

Publisher: New South Wales Department of Primary Industry, Kite St., Orange New South Wales, Australia

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Keywords: Alfalfa, yield, harvest date.

Introduction

In a temperate region, alfalfa (*Medicago sativa*) crops are usually harvested 3-6 times per annum. The biomass yields of first and second cuts in the spring are generally the highest. However, in subsequent cuts the biomass yields decline, with the final 1 or 2 cuts producing the lowest yields (Wang *et al.* 2009). This seasonal reduction in alfalfa biomass yields could be associated with prevailing changes in environmental factors such as rainfall and heat stress or due to biological characteristics of alfalfa crop itself. In this study, alfalfa was grown under controlled greenhouse conditions with suitable temperature, light, water and nutrient supply to determine the driving force in cut-to-cut biomass yield variations among alfalfa genotypes.

Methods

A controlled greenhouse study with 8 alfalfa varieties (Empress2000, Phabulous, Vernel, Victoria, WL232HQ, WL323HQ, WL343HQ and WL525HQ), arranged in a completely randomized design with 4 replicates was conducted. The greenhouse was set with 16 hrs photoperiod and temperatures set at 20/15°C (light/dark). The PAR light intensity was approximately at 400 µE/m2/s. Nutrient solutions were provided weekly. Once the crop reached early blooming stage, plant height, net photosynthetic rate (Pn) and leaf chlorophyll content were measured. Biomass yield was determined 6 times during the course of the experiment.

Results and discussion

Unlike field conditions, biomass yield increased from cut 1 to cut 3 with maximum yields of all varieties at cut 3. There was no significant change in dry matter yield from cut 3 to cut 6, but the greatest yields were achieved at the cut 5 and cut 6 (Fig. 1 a). There was minimum difference in plant height, leaf chlorophyll and photosynthesis (Pn) from one cut to the next, but generally lower chlorophyll meter readings (SPAD) in cut 2 and lower photosynthetic rate in cut 3 (Fig. 1 bcd).

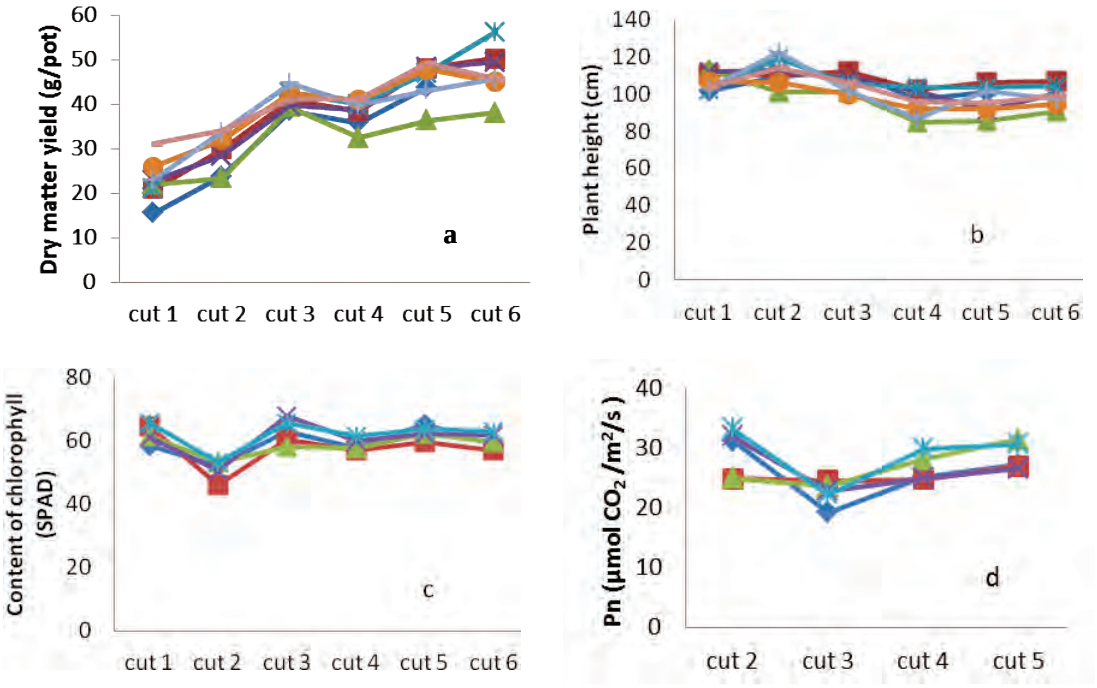

Figure 1. Dry matter yield (a), plant height (b), leaf chlorophyll meeting reading (SPAD), (c) and photosynthetic rate (Pn, d) of 8 varieties grown under controlled greenhouse conditions.

Table 1. Correlation coefficients between dry biomass yield and plant height, photosynthetic rate (Pn) and leaf SPAD readings.

	Cut 1	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6
Plant height	-0.40ns	0.76*	-0.06ns	0.60ns	0.68ns	0.87**
Chlorophyll	0.62ns	-0.23ns	0.18ns	0.72*	0.83**	0.18ns
Pn	??	0.39ns	-0.06ns	0.56ns	0.38ns	nd

*, ** Significant at 0.05 and 0.01 level of probabilities, respectively; ns = not significantly different; nd = not determined

Dry matter yield was positively correlated with plant height at cut 2 and cut 6, while correlation between dry matter yield and chlorophyll meter readings was positively correlated at cut 4 and cut 5, but without correlation in other cuts. There was in general no correlation between dry matter yield and Pn (Table 1).

Conclusions

As the alfalfa plants develop, its dry matter yield increased from cut 1 to cut 3. The yields after cut 3 were stable and each cut yielded similar biomass. Without high temperature, water deficit and nutrient limitations, biomass yields of alfalfa crop remained similar or even increased from earlier to later cuts. Our data implies that decline in biomass yield after cut 2 under field conditions was unlikely the result of genetic characteristics of the crop itself, but the influence of environmental factors. Experimentation is underway to identify major yield limiting factors for alfalfa under field conditions.

References

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